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❶ European Patent number

1 Please give the European Patent number: 0 599 213

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I, Derek Ernest LIGHT, B.A., B.D.Ü.,
translator to RWS Group plc, of Europa House, Marsham Way, Gerrards Cross, Buckinghamshire, England, hereby declare that I am conversant with the German and English languages and that to the best of my knowledge and belief the accompanying document is a true translation of the text on which the European Patent Office intends to grant or has granted European Patent No. 0,599,213
in the name of ROBERT BOSCH GMBH

Signed this 7th day of April 1999

D. E. LIGHT

For and on behalf of RWS Group plc

The invention relates to an arrangement according to the preamble of Patent Claim 1.

A monolithically integrated semiconductor component in which an optical waveguide and a photodetector are applied to opposite sides of a semiconductor substrate and in which a reflective face, which extracts radiation from the optical waveguide and feeds it through the semiconductor substrate to the photodetector (EP 0 192 850 A1), is provided.

US 5,101,460 describes how an individual light beam is divided by a holographic element, which is located between two transparent carriers, into a plurality of light beams, with the result that each individual light beam is deflected with respect to the corresponding light-receiving element.

DE 39 14 835 C1 discloses an arrangement for coupling an optical waveguide to an optical transmitting or receiving element. Here, the optical waveguide and the optical transmitting or receiving element are located on different carriers which lie one on top of the other with their carrier surfaces in a displaceable fashion. The light beam between the optical waveguide on the one hand and the transmitting or receiving element on the other passes through double reflection at in each case one mirror plane, located on the carriers, from the optical waveguide to the optically active element, or vice versa. By displacing the carriers with respect to one another, a lateral adjustment of the light beam with respect to the optical waveguide or optically active element is achieved.

The object of the invention is to specify an arrangement with which a plurality of light-emitting and/or light-receiving elements can be coupled to an optical waveguide. In particular, the intention is that this coupling will also be made possible in an optional way.

The object is achieved by means of an arrangement having the features of Patent Claim 1.

Advantageous developments are specified in the subclaims.

The arrangement according to the invention can be used to couple either an optical waveguide, which is located in a carrier for example, or a strip transmission line. Coupling to a plurality of light-emitting and/or light-receiving elements is provided. Said elements are located on a carrier on which the corresponding electrical components for driving the electrico-optical elements may be located. Between the two carriers, one of which is fitted with the optical waveguide and the other with the transmitting and/or receiving elements, there is a light-transmitting intermediate layer in which the light beams are divided in preselected directions. The intermediate layer may be, for example, a Fresnel lens. The two carriers can either be arranged so as to be displaceable one on the other in order to permit adjustment, and be, for example, bonded after the adjustment, but it is also possible to adjust the two carriers with respect to one another by means of anisotropically etched complementary structures in the carrier surfaces. Apart from the two carriers mentioned above, further carriers may also be provided between them, it being possible, for example, for one carrier to be fitted with a series of switches, or at least one switch, which can be switched between the light-transmitting and opaque states. Such a switch may be, for example, a planar element which can be switched electro-optically or thermo-optically, in particular an LCD. These elements are introduced into the beam paths between the intermediate layer of the transmitting or receiving elements, as a result of which an optical waveguide can optionally be connected to a specific transmitting element or receiving element or to a plurality of such elements.

The German Patent Application P 42 39 534 discloses how an optical waveguide is led in a groove on the underside of a silicon carrier. The light

emerging from the end of the optical waveguide is introduced into the silicon carrier, the light penetrating the silicon carrier virtually perpendicularly and emerging on its upper side again. Instead of an optical waveguide, a strip transmission line may also be used. The underside of the silicon carrier is aligned parallel to a crystallographic (100) plane of the silicon. The light beam emerges from the optical waveguide into the interior of the silicon wafer. At a short distance from the end of the optical waveguide, a further depression is anisotropically etched. The light beam is incident on the inclined edge face of this depression, which serves as a reflective face. It is totally reflected there because the critical angle of total reflection for emergence from the silicon is exceeded. This arrangement which is known from P 42 39 534 can also be used in the solution according to the invention.

Figure 1 represents an exemplary embodiment of the invention.

In Figure 1 there is a strip transmission line 1 on a carrier 2. A reverse side 21 has an optical waveguide 1. The light which emerges from the strip transmission line 1 is totally reflected at the reflective face 3. The light beam 11 emerges from the carrier 2 on the base face 20 lying opposite the reverse side. On the carrier 2 there is a further carrier 2' and a carrier 4 lying between them. Between the carrier 4 and the carrier 2 a Fresnel lens is provided for light scattering 181 which divides the light beam 11 into light beams 111, 112, 113 with predefined directions. The light beams 111, 112, 113 are each incident on a light-emitting and/or light-receiving element 131, 132, 133. These light-emitting/light-receiving elements are located on the reverse side 21' of the carrier 2'. In each beam path 111, 112, 113 there is a switch 174 to 176. Using these switches, the light can be switched between the outputs as desired.

These switches can be planar electro-optical or thermo-optical switchable elements, for example LCDs. In another exemplary embodiment, the switchable elements are arranged directly under the light-emitting or light-receiving elements on the surface 21'.

Instead of the light-emitting or light-receiving elements 131-133, it is also possible for light-radiating or light-receiving striplines or fibre ends in V-grooves to be provided as light-emitting or light-receiving elements.

Patent Claims

1. Arrangement for coupling an optical waveguide (1) to a plurality of light-emitting or light-receiving elements (131, 132, 133) having a first light-transmitting carrier (2), having a base face and reverse side lying opposite in which there is an optical waveguide (1) and a reflective face (3), having a second light-transmitting carrier (2') with a base face and reverse side, on which light-emitting and/or light-receiving elements (131, 132, 133) are arranged, having a light-transmitting intermediate layer (181), which is arranged between the base faces (20, 20') of the first and second carriers (2, 2'), the intermediate layer (181) having an area which divides up an incident light beam (11) into a plurality of light beams (111, 112, 113) with predefined directions, and having a switching element (174, 175, 176) which can be switched between the "light-transmitting" and "non-light-transmitting" states and which is arranged between the light-emitting and/or light-receiving elements and the aforesaid region of the intermediate layer in the beam path of one of the plurality of light beams, the arrangement being designed in such a way that the light beam which emerges from the optical waveguide is incident, via the reflective face, on the aforesaid region of the intermediate layer, and that each of the plurality of light beams which emerge from the aforesaid region of the intermediate layer is incident on one of the light-emitting and/or light-receiving elements.

2. Arrangement according to Claim 1, in which the intermediate layer is a lens, in particular a Fresno lens (181).

3. Arrangement according to one of Claims 1 or 2, in which the first carrier is made of silicon, in which the optical waveguide (1) on the reverse side (21) is guided in a groove, in which the reverse side (21) of the silicon carrier (2) is aligned parallel to a

crystallographic (100) plane of the silicon, in which a further depression is etched anisotropically at a short distance from the end of the optical waveguide, so that the light beam from the optical waveguide is incident on the inclined edge face of this depression, which serves as a reflective face, and is totally reflected there, so that it penetrates the silicon carrier (2) almost vertically and emerges again from its base face (20).

4. Arrangement according to one of Claims 1 to 3, in which planar electro-optical or thermo-optical switchable elements (174, 175, 176), in particular LCDs, are used.

5. Arrangement according to one of Claims 1 to 4, in which, after adjustment, the carriers (2, 2', 4) are secured to one another, in particular by adhering or bonding.

6. Arrangement according to one of Claims 1 to 4, in which the carriers (2, 2', 4) are displaceably arranged on one another.

7. Arrangement according to one of Claims 1 to 4, in which structures which are anisotropically etched in a complementary fashion and whose edges serve to support the carriers one on top of the other are located on the base faces of the carriers.

8. Arrangement according to one of Claims 1 to 4, in which anisotropically etched structures (17), whose edges serve in each case to support at least one auxiliary element (18) which is common to the two carriers (2, 2'), are located on the base faces of the carriers (2, 2').

9. Arrangement according to one of Claims 1, 2 or 4 to 8, in which the reflective face (3) is totally reflective.

10. Arrangement according to one of Claims 1 to 9, in which the optical waveguide is a stripline.

11. Arrangement according to one of Claims 1 to 10, in which there is provision for the optical waveguide

to be coupled to light-emitting or light-receiving elements at both ends of the optical waveguide.

12. Arrangement according to Claim 11, in which the optical waveguide runs entirely in a carrier.

13. Arrangement according to one of Claims 1 to 12, in which opto-electronic transmitting or receiving elements are provided as light-emitting and/or light-receiving elements.

14. Arrangement according to one of Claims 1 to 12, in which optical waveguide ends are provided as light-emitting and/or light-receiving elements.

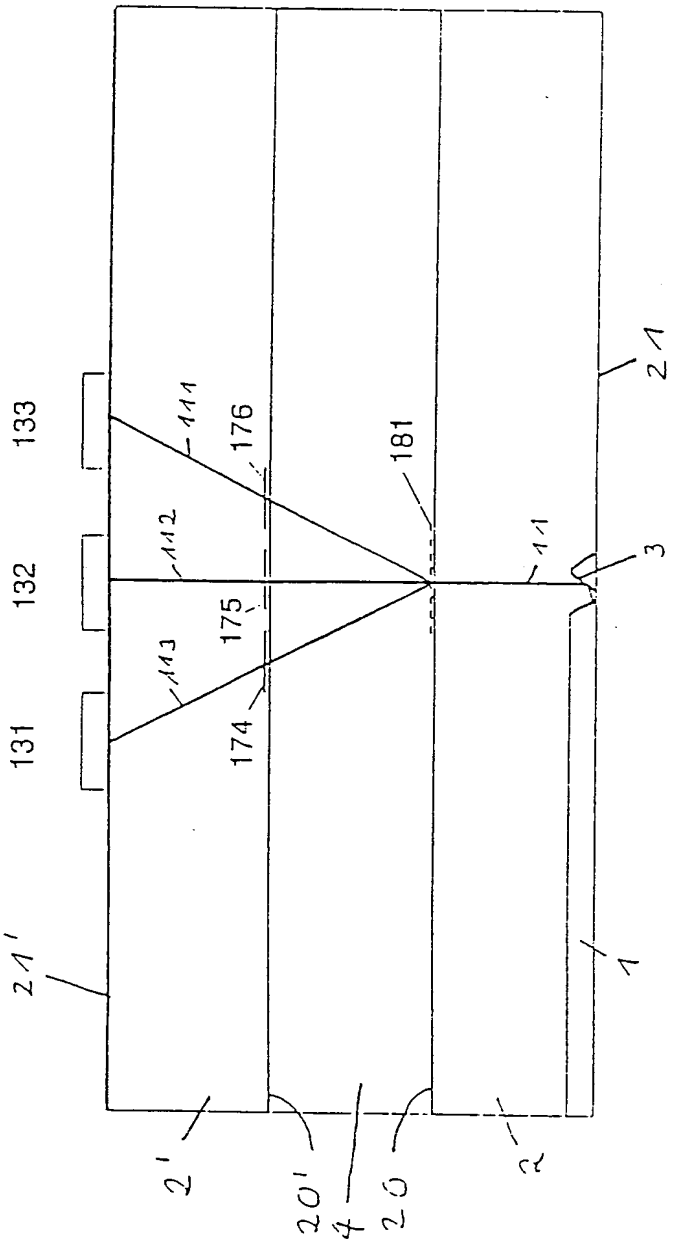

Fig. 1